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ABSTRACT

This teacher's guide presents teaching suggestions and presentation materials on the serious and growing problem of watershed (river basin) pollution, what it is, and what actions citizens can take to reduce it. The lesson is divided into seven parts and may be completed in two or more class periods. Student handouts include: (1) "Watershed Map and Questions"; (2) "Events in the Watershed"; (3) "Facts about Watershed Pollution"; and (4) "Comparing Water Use and Pollution in Industrialized and Developing Countries." Transparency masters are titled: (1) "Major River Basins of the World"; (2) "How Water Becomes Polluted"; and (3) "Watershed of the Chesapeake Bay." (EH)

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TEACHER'S GUIDE

Watershed Pollution

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to

World Resources:

Watershed Pollution

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Teacher's Guide

to

World Resources:

Watershed Pollution

Comprehensive Coursework on the
Global Environment

World Resources Institute
1709 New York Avenue, N.W., Washington, DC 20006

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Using World Resource Teacher's Guide Unit

World Resources *Teacher's Guide* Units are designed for use at the secondary school level (although we have reports of successful use at the middle school and college levels). They weave together lessons about both environment and development, both globally and locally. They draw on skills and knowledge from the physical and biological sciences, social studies, history, economics, civics, and global studies.

Information and analysis used in the Units are drawn from World Resources Institute (WRI) publications and databases. All units are written by curricula writers and reviewed by educators as well as by technical experts. The Units are updated and revised periodically based on feedback from classroom teachers who have used the materials.

Our intent is to provide easy-to-use, inexpensive classroom materials that contain the most recent and authoritative information on the global environment because we believe it is crucial that the next generation of leaders and citizens understand the issues described here.

The complete set of *Teacher's Guide* Units includes the following topics:

- Biodiversity
- Car Trouble
- Citizen Action
- Energy, Atmosphere, and Climate
- Natural Resource Economics
- Oceans and Coasts
- Population, Poverty, and Land Degradation
- Sustainable Development
- Two Giants: China and India
- Watershed Pollution
- Women, Equity, and Sustainable Development

These units have been revised and updated with the most recent data available as of spring 1994.

Inside Each Unit

Each *Teacher's Guide* Unit should contain enough teaching suggestions and presentation materials to teach one to several classes on the topic without securing additional resources. On the other hand, each unit is designed to point teachers and students to additional resources and to offer suggestions for expanded coursework. Specifically, each unit contains objectives, a lesson plan, student handouts, overhead transparency masters, student enrichment activities, suggestions for further reading, and suggested audiovisual resources.

Using the Units for Environmental Studies

The *Teacher's Guide* Units provide a comprehensive, consistent yet highly flexible set of materials for environmental studies courses. They can be used in conjunction with an environmental science textbook to give students an understanding of basic environmental systems and cycles. Or they can be used in a social studies context to examine some of the tough problems and choices we face as a society.

Educators who want to go beyond the *Teacher's Guide* Units can read related WRI publications, which provide the basic data, source materials, and analysis for the Units. These publications are listed at the beginning of each unit. A free catalog can be obtained by calling 1-800-822-0504.

Integrating Teacher's Guide Units into the Curriculum

Secondary school teachers frequently mention the difficulty of integrating environmental issues into a tightly packed curriculum. As much as they would like to teach about the environment, they must devote class time to required subjects.

To help them place these issues in their curricula, we have coded each lesson plan and each student enrichment activity to the draft national performance assessment standards for science, math, history, civics, and geography. These standards are being developed as part of the national Goals 2000 program in the U.S. Department of Education. The standards themselves are being developed, discussed, and revised by educational organizations in nine academic disciplines. They are expected to be approved at the national level, then offered to states to incorporate into their own academic assessment plans. Although this process will take several years, we have compiled lists of assessment standards for grades 9 through 12 from drafts available in spring 1994 to offer some guidance to teachers.

A complete list of the draft standards for Grades 9 through 12 appears in Appendix B, which should be mailed to you with your order. Appendix A provides a bibliography and list of related organizations.

Integrating Global Environmental Education into High School Curricula

In an effort to link lessons about global environment and development issues to required school curricula, we have identified which pages of the lesson plan and which student enrichment activities in this *Teacher's Guide* Unit relate to the draft national performance standards developed recently for civics, geography, history, math, and science in grades 9 through 12.

These voluntary national standards are part of the Goals 2000 program mandated by the Goals 2000: Educate America Act of 1994 under the direction of the U.S. Department of Education. Among other things, Goals 2000 will establish a set of goals or performance standards for grades 4, 8, and 12 in the subjects listed above plus English, the arts, and foreign languages. These goals will be available to the states for incorporation into their own sets of educational performance standards. Each set of draft standards was developed by a professional education organization and has been presented at numerous educational conferences for review and comment. The draft standards used here are those available as of spring 1994.

Although many countries have national performance standards, the United States (and Canada) have treasured a decentralized educational system that sets education goals at the district or state level. Goals 2000 is the first attempt to identify a set of general education objectives that all students in the country are expected to achieve. As might be expected, there is some controversy over whether there should be national education goals—even voluntary ones—and if so, what they should be.

Regardless of the final outcome, we feel the draft goals do reflect some consensus among educators about what material should be covered at various grade levels, and as such, offer some guidance for integrating environmental education into the curricula.

Only those goals relevant to this unit are listed here. A complete list of goals appears in the 1994 *Teacher's Guide to World Resources*. Copies of reports outlining the goals for each subject area can be obtained from the education organizations listed at the top of each set of goals on this page. Information about the Goals 2000 program is available at 1-800-USA-LEARN.

Goals 2000: Draft National Performance Standards

Civics and Government*

(Draft National Standards, October 1993, Center for Civic Education, 5146 Douglas Fir Road, Calabasas, CA 91302-1467)

	Lesson Plan	Enrichment Activity
III. How Does the Government Established by the Constitution Embody the Principles and Purposes of American Democracy?		
2. What does the national government do and how can it be influenced?	7	
3. How are state and local governments organized, what do they do, and how can they be influenced?	7	8
4. What is the role of law in the American political system?		8
6. How is public policy formulated and carried out?		8

History*

(Draft National Standards, October 1993, National Center for History in the Schools at UCLA, 231 Moore Hall, 405 Hilgard Avenue, Los Angeles, CA 90024)

	Lesson Plan	Enrichment Activity
I. Historical Chronology		
1. Distinguish between past, present, and future time.		1
8. Reconstruct patterns of historical succession and duration and apply them in explaining historical continuity and change.		1
IV. Historical Analysis		
4. Demonstrate and explain the influence of ideas, human interests, beliefs and ideologies on individual and group historical actions and their consequences.		1

Note: Only the education goals relevant to this unit are listed.

Geography*

(Draft National Standards, October, 1993, National Council of Geographic Education, Geography Standards Project, 1600 M Street, NW, Washington, DC 20036)

	Lesson Plan	Enrichment Activity
I. Seeing the World in Spatial Terms		
1. Knows and understands how to use maps, globes, and other graphic tools and technologies to acquire, process, and report information from a spatial perspective.	2-5, 7, 8	1-3, 6
3. Knows and understands how to analyze the spatial organization of the Earth's surface.		1-2
II. Elements: Places and Regions		
4. Knows and understands the physical and human characteristics of place.		1
III. Physical Systems		
7. Knows and understands the physical processes that shape the patterns on Earth's surface.	2	1
8. Knows and understands the characteristics and distribution of ecosystems on Earth's surface.		1
IV. Human Systems		
9. Knows and understands the characteristics, distribution, and migration of human populations on Earth's surface.		1-2, 6
11. Knows and understands patterns and networks of economic interdependence on Earth's surface.		1
12. Knows and understands the processes, patterns, and functions of human settlement.	3-5	1-3, 6
V. Environment and Society		
14. Knows how Earth's dynamic physical and human systems are connected and interact.	3-8	1, 2, 6
15. Knows the consequences of the interaction between dynamic human and physical systems.	3-8	1, 2, 6
16. Knows changes in the meaning, distribution, and importance of resources.	4-7	1, 2, 6

Mathematics*

(Draft National Standards, March 1989, The National Council of Teachers of Mathematics, Order Processing, 1906 Association Drive, Reston, VA 22091)

	Lesson Plan	Enrichment Activity
X. Statistics		
1. Construct and draw inferences from charts, tables, and graphs and summarize data from real-world situations.		4

Science*

(Draft National Standards, February 1994, National Academy of Sciences, National Research Council, 2101 Constitution Avenue, NW, Washington, DC 20418)

	Lesson Plan	Enrichment Activity
II. Physical Sciences		
2. Chemical Interactions	6, 7	5, 6, 11
III. Life Science		
4. Ecosystems and Human Ecology	2-9	1-12
VI. Science and Technology		
1. Problem Identification	6-8	9
3. Solution Implementation		12
4. Solution Evaluation	7	
VII. Science and Societal Challenges		
1. Population Growth	5	
2. Natural Resources	2-9	1-12
3. Environmental Degradation	3-9	1-12
4. Natural and Human-Induced Hazards	3-9	1-12
5. Community Health	3-5, 7, 8	1-3, 5-9
6. Global Change	5	6

Watershed Pollution

If you were asked to list things that move in the water, you might mention a crab scuttling abruptly sideways or a fish gliding away with a flick of the tail. Other things also move in the water; some are visible, such as a bobbing empty plastic bottle, a multi-colored oil slick, or a cloud of brown mud; others are invisible, such as disease-causing bacteria, toxic chemicals discarded by factories, or fertilizers from farms and suburban gardens.

This lesson examines watershed pollution, a serious and growing problem. Most of the world's people live along rivers and in coastal areas. Water is essential for their life and for the basic activities that sustain them. The lesson begins by defining a watershed and introducing the process by which pollutants enter and travel along streams, rivers, and lakes to coastal areas. Using an inquiry exercise, students investigate events that affect the health of an imaginary watershed. The lesson then compares water use and water pollution in industrialized and developing countries and analyzes the causes and costs of water pollution. Finally, it takes a look at strategies to deal with watershed pollution and asks students to identify steps they and their families can take.

Objectives

By the time they finish this lesson, students should be able to:

- Define watershed.
- Describe how different kinds of pollutants enter the water and move through the watershed toward coastal areas.
- List ways in which humans use water and describe how pollution can both be affected by and affect these uses.
- List types of pollutants and describe their effects on humans and aquatic life.
- Identify steps at the local, national, regional, and global levels that can help reduce water pollution and evaluate each in terms of its potential positive and negative effects.
- Compare and contrast water consumption patterns in industrialized and developing countries.
- Identify actions that students and their families can take to conserve water and reduce water pollution, and evaluate each in terms of its potential positive and negative effects.

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Teaching Strategies

The lesson is divided into seven parts. You will need two to three class periods, or more if you wish to pursue any of the topics in greater detail or add activities. The lesson includes the following materials that may be duplicated:

Student Handouts:

1 Watershed Map and Questions
2 Events in the Watershed
3 Facts about Watershed Pollution
4 Comparing Water Use and Pollution in Industrialized and Developing Countries

Overhead Transparency Masters:

1 Major River Basins of the World
2 How Water Becomes Polluted
3 Watershed of the Chesapeake Bay

Beginning the Lesson

Define the term *watershed*: the land area drained by a river and its tributaries. *River basin* is a synonym for watershed.

Show a transparency made from **Overhead Transparency Master 1, "Major River Basins of the World."** Watersheds are dominant features of the Earth's surface. They range in size from the tiny watersheds feeding coastal streams along the mountainous Napali coast of Hawaii to the basin of the Amazon River, which covers an area twice the size of India. Except for a relatively few communities in some desert and tundra areas, humans live in river basins.

Explain that a river can be divided into three parts:

1. **Headwaters.** Very steep, small streams fed by rain, snow, glaciers, or springs. Water flows rapidly.
2. **Middle.** Water flows more slowly through comparatively flat land. Often surrounded by a floodplain, which is inundated after a heavy rainfall or melting snow. Marshes and lakes are often along or near the river.
3. **Mouth.** Freshwater mixes with salt water. Currents are slower.

After looking at global watersheds, use a map of your region to trace local streams and rivers from their source to the coast. Is your community near the headwaters, middle reaches, or mouth of a river? Sources for maps include:

Naniamo Maps and Charts
8 Church Street
Naniamo, British Columbia
Canada V9R 5H4
(Maps available for a charge.)

United States Geologic Survey
(Department of the Interior)
Branch of Distribution
Box 25286, Federal Center
Denver, CO 80225
(303) 236-7477
(Topographic maps. An index of topographic maps by state is available free of charge.)

United States Geologic Survey
EROS Data Center
Sioux Falls, SD 57198
(605) 594-6151
(Aerial photos and remote sensing images are available based on the latitude and longitude of a location.)

Introducing the Pollution Process

A watershed can become polluted in many different places and in many different ways. Use a transparency made from **Overhead Transparency Master 2, "How Water Becomes Polluted,"** to discuss how pollutants enter surface water and groundwater and how they travel through the watershed. This figure illustrates what is known about the pollution process generally, but it is important to know that scientists are relatively ignorant of how pollutants behave and are transported through surface and groundwaters. This lack of knowledge becomes important in trying to deal with water pollution.

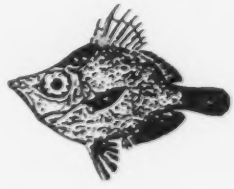
Analyzing a Watershed

The inquiry exercise, "Watershed Watch," is designed to introduce some of the important themes of this lesson:

- The watershed of a river covers a large area of land.
- Within a watershed, there are many different human activities that use water and affect water quality.
- Watershed pollution is a complex problem because there are so many different kinds and sources of pollution.
- Once pollutants are introduced into the watershed, they can travel long distances.
- Because pollutants travel downstream to the coasts, it is impossible to keep coastal areas clean without dealing with watershed pollution.

Three student handouts can be used for the inquiry exercise. **Handout 1, "Watershed Map and Questions,"** is a map of an imaginary watershed in the United States along with questions. **Handout 2, "Events in the Watershed,"** is a list of events at locations in the watershed during a three-month period. **Handout 3, "Facts about Watershed Pollution,"** gives supplementary information. You may wish to have students study this fact sheet before beginning the lesson.

The exercise is designed as a small group activity. Give each student a copy of **Handout 1**. Give each group a pack of "event cards" (Note: Text for **Handout 2** is set up in columns so that each event can be cut into a separate piece and glued to an index card). Divide cards among students. Have students take turns reading each event aloud, locating the corresponding location on the map, and answering questions in Part I of **Handout 1**. One student in each group should record the answers. After each group has also developed answers to the questions in Part II, compare the groups' answers in a general class discussion.



While the watershed is imaginary, the events are based on real events and recent trends (as outlined below). You might want to add events from the local or national news.

1. Deposits of toxic metals found . . . *(Allied Chemical Plant in Baltimore's Inner Harbor, Maryland, 1990).*

2. City budget problems . . . *(New York City, as reported in the* New York Times, *July 1991.)*

3. Marshes set aside as wildlife sanctuary. . . *[Joseph P. Fried, "After a Long Battle, A Queens Tract of Marshes Becomes a Park Preserve," New York Times (November 23, 1990), p. B3.]*

4. Tanker hits ship during storm. . . *(This type of accident is common. A 1989 accident in Galveston Bay spilled 6,000 barrels of oil.)*

5. Railroad tanker car derails on bridge. . . *(Southern Pacific Railroad accident near Dunsmuir, California, on the Sacramento River, July 1991. The pesticide being transported killed tens of thousands of fish.)*

6. Toxic metals buried 20 years ago have leaked. . . *(See* World Resources 1992-93, *p. 168.)*

7. Increased fines and new technology cut down on chemicals in waste water. . . *(The Eaton Corporation of Humboldt, Tennessee, a manufacturer of truck axle housings, cut waste water generation from 1.8 million liters to 0 liters and saved $191,200 per year. See* World Resources 1992-93, *p. 170.)*

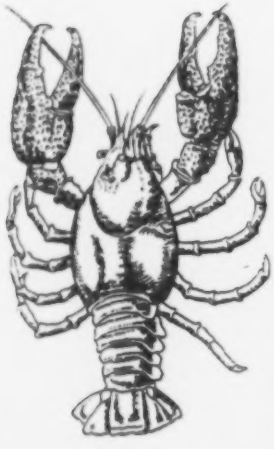
8. Heavy thunderstorm overloads storm sewers. . . *(Most U.S. cities have combined sewers for sewage and storm water runoff. After a heavy storm, it is common practice for excess water to bypass treatment and flow directly into the river.)*

9. Forest is cleared to make way for new planned community . . .

10. Farmers cut down on fertilizer and pesticide use and reduce soil erosion. *(For more information on the relationship between farming practices and water pollution, contact the Chesapeake Bay Foundation, 162 Prince George Street, Annapolis, MD 21401.)*

11. Town budget squeeze . . . *(New York City, July 1991.)*

12. Barge hits stone jetty and spills kerosene. *(In 1987, a freighter struck a stone jetty at the mouth of the St. Johns River, Jacksonville, Florida, spilling more than 100,000 gallons of fuel oil into the water.)*



13. Pipes draining raw sewage into the river. *(New York City, July 1991. A two-and-a-half year survey by the City Department of Environmental Protection found 171 pipes discharging a total of about 4.5 million gallons a day of untreated sewage. About two-thirds of these pipes were city owned, and the rest were owned by private companies or other government agencies.)*

14. Island has six new subdivisions under construction. *(Tilghman Island, Maryland. State environmental officials ordered the island to build a waste water treatment plant in the mid-1980s. Opponents feared this would bring land development. The oyster beds around the island are no longer polluted, but farms are being subdivided and expensive housing is being built.)*

15. Small factory illegally dumping nitric acid into sewers. *[The owner of a small factory in Burlington, Massachusetts, was convicted of pouring nitric acid and nickel wastes down a sink. Charges were brought by the Environmental Protection Agency's criminal enforcement division. Some states are also acting: Massachusetts has formed an Environmental Crimes Strike Force. David Stipp, "Toxic Turpitude: Environmental Crime Can Land Executives in Prison These Days,"* Wall Street Journal *(September 10, 1990) .]*

16. City upgrades sewage treatment plant . . . *[In the United States, secondary treatment is required in all waste water treatment plants. However, after secondary treatment, the following remain in the waste water: 3–5 percent of the oxygen-demanding waste; 3 percent of the suspended solids; 50 percent of the nitrogen (as nitrates); 70 percent of the phosphorus (as phosphates); 30 percent of the toxic metals; and 100 percent of any pesticides or long-lived*

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radioactive isotopes. G. Tyler Miller, Jr., Living in the Environment, *6th ed. (Wadsworth Publishing Company, Belmont, California, 1990), p. 541.]*

17. New dam reduces flow of freshwater and nutrients to the bay. *Estuaries depend on seasonal flows of freshwater to provide nutrients and to maintain salinity levels appropriate for estuarine organisms. Blocked freshwater flows can increase salinity above tolerable limits.*

18. Medical waste is washed up on shore. *(One of the most publicized occurrences was along New York beaches in 1988; the New York Sanitation Department assigned members of its environmental police force to walk city beaches each day, looking for hypodermic needles and other medical wastes.)*

19. Sale of shellfish restricted/unsafe levels of toxic industrial chemicals. *(The James River in Virginia near the Chesapeake Bay was closed to oystering because oysters were contaminated with kepone in the 1980s.)*

20. Catch of fish drops after sediments from upstream erosion cloud river waters. *(A study in Bacuit Bay, Philippines showed a loss of both coral reefs and fish following heavy sedimentation by soil eroded from logged hillsides.*

Comparing Water Use and Pollution Around the World

"Watershed Watch" discusses watershed pollution in the United States, an industrialized country. Water pollution is a serious and growing problem in developing nations as well. Use **Handout 4, "Comparing Water Use and Pollution in Industrialized and Developing Countries,"** to discuss similarities and differences. Two points to emphasize are that:

- Developing countries are likely to have few or no laws against dumping of hazardous industrial wastes.
- Soil erosion and sewage are more serious problems in developing countries than in industrialized ones.

Some additional questions you may wish to use are:

Why do many city dwellers in developing countries not have access to safe drinking water? Both domestic sewage and industrial wastes are not treated. Many people live in informal or squatter settlements with no water and sanitation services.

Why does per capita water use increase as living standards go up? (See **Activity 4, "Estimate Water Usage."**)

Are water quality and water quantity two different issues? No. As water becomes polluted, the supply of usable water is reduced. It is expensive and difficult to treat water once it becomes polluted. For example, by 1986, 39 percent of the river water in Poland had become so polluted it could not be used even for industrial purposes.

How does using more water contribute to water pollution? Once water has been used, it is returned to rivers as "waste water." Sometimes this waste water is treated to remove chemicals and nutrients, but too often it is not treated. Even when it has been treated, waste water usually needs to be diluted to further reduce concentrations of pollutants before the water is fit for reuse. The potential for dilution of waste water is increasingly limited because as water withdrawals for various

uses increase, there is less clean water available for diluting water affected by pollutants. During the past three centuries, the amount of water withdrawn by humans has increased 35 times. Water withdrawals are stabilizing in industrialized countries but are increasing in developing countries. In many countries—in North Africa and the Middle East, for example—water withdrawals appear to be occurring at unsustainable rates.

Why are fertilizers and pesticides becoming a growing problem in developing countries? Heavier applications of fertilizers and pesticides have been part of the Green Revolution. Global fertilizer use has increased dramatically since 1970, especially in Asia and particularly in China. There have been large increases in pesticide use during the last 20 years. Pesticide and fertilizer contamination is a serious problem in newly industrialized countries such as South Korea.

How does air pollution contribute to water pollution? Acid rain, snow, fog, and cloud vapors are formed when fossil fuels are burned, releasing SO_2 and NO_x. Acid precipitation occurs in highly industrialized areas and is a problem in North America and Europe. China has also begun to experience some regional acid rain problems.

Analyzing Causes of Water Pollution

To summarize, discuss how each of the following has contributed to making water pollution such a serious global problem:

- Priority given to economic development regardless of environmental consequences.
- Belief that disposing of human and industrial wastes in water is satisfactory—that there are few or no bad effects.
- Lack of knowledge about where and how pollutants are entering the water (for example, underground wastes leaching into groundwater).
- Lack of understanding of how pollutants move through the watershed.
- Lack of understanding of the relationship between inland activities, such as farming and logging and coastal pollution.
- Belief that wetlands are "wastelands" and should be converted to other uses such as dumps, or dredged and filled in for use as building sites.
- Lack of legal restrictions on disposing of wastes.
- Lack of money to build waste water treatment plants.
- Population growth and increasing demand for water.
- Fragmentation of authority. Usually, a watershed contains many different political jurisdictions. Within countries or states, agencies responsible for clean water have no control over activities that affect quality or quantity of available water (for example, location of hazardous waste dumps, urban development).

Identifying Costs of Watershed Pollution

While cleaning up polluted water is expensive, allowing water pollution to continue or increase is also costly. Discuss these costs, for example:

- Threats to human health. According to the Preparatory Committee for the United Nations Conference on Environment and Development (UNCED), waterborne infectious diseases affect more people in developing countries than any other health problem. The cholera outbreak in Latin America is a current example. Also, contaminated fish and shellfish are a health threat (for example, fish contaminated with mercury).
- Destruction and contamination of aquatic and marine life, especially in wetlands and on coral reefs.
- Destruction of commercial fisheries that are sources of food and jobs.
- Degradation and destruction of rivers and coasts as recreation areas.
- Reduction in the amount of water available for domestic, agricultural, and industrial use. This is especially important where populations and demand for water are growing.
- Conflicts among users over quantity and quality of water. This is occurring among states in the United States and among nations that share watersheds.

Developing Strategies for Dealing with Watershed Pollution

Encourage students to develop a list of possible strategies for reducing watershed pollution. Show the transparency made from **Overhead Transparency Master 2, "How Water Becomes Polluted,"** for a second time. Can students suggest ways to reduce pollution from each of the various sources?

Any plans to deal with watershed pollution have to be made on a large scale and encompass a whole region that includes various political entities (counties, states or provinces, nations). Regional planning is critical. It is also important to research and identify the sources of pollution, as much as is possible. This is a complex, difficult, and expensive process.

Show a transparency made from **Overhead Transparency Master 3, "Watershed of the Chesapeake Bay."** The Chesapeake Bay is America's largest estuary. A multi-million-dollar, seven-year study by the U.S. Environmental Protection Agency (EPA) considered the bay's ecology and hydrology and traced pollution sources. This study was one of the first to document how much coastal pollution may come from upstream sources. Three rivers were found to carry 78 percent of the nitrogen and 70 percent of the phosphorus entering the bay.

Many actions have been taken by states in the bay's watershed to reduce the amounts of pollutants washing into the bay. Some of these actions were taken in Pennsylvania and New York—states that do not border on the bay, but are in the bay's watershed.

Strategies for dealing with watershed pollution must also involve many different groups, both public and private. For example, the State of Maryland has targeted four watersheds and is making a comprehensive plan for each—government agencies, private organizations and individuals have joined to form watershed targeting teams. Each team is responsible for evaluating the stream, developing and implementing a cleanup program, monitoring the results, and involving area residents in restoration of the stream. Activities include planting trees along streams, setting up monitoring stations to track nutrients over a long period of time, and erosion control projects. Agricultural techniques aimed at reducing pollution—known as best management practices—are also being used. Such practices include plowing along the land's natural contours to reduce erosion from rainfall and storing manure to keep it out of streams.

Concluding the Lesson

End the lesson by considering the watershed in which you live. (See **Activities 2, "Follow a River,"** and **3, "Study Your Water Supply."**)

What is the condition of local streams and rivers? What has been the trend in water quality over the past 10 years? Are there any special protected watershed areas? Are there any special local problems with pollution? Where does your community's drinking water come from? If your water source is a river, what communities and industries use the water upstream from you? What communities downstream from you depend on the river for their water supply? Where does your river meet the sea? What is the state of coastal pollution at the river mouth? What trends are revealed in fish catches and contamination? Data on water quality can be obtained from your regional Environmental Protection Agency Office or Environment Canada office. Coastal fish catch data are available from the National Marine Fisheries Service or Fisheries and Oceans Canada, Information Services. Addresses are given at the end of this Guide.

Students concerned about water pollution can take constructive action. Encourage them to act as individuals and in groups.

As individuals they can:

- Join with their families to conserve water (see **Activity 4, "Estimate Water Usage"**) and reduce household use of water pollutants such as fertilizers, pesticides, and household cleaners. (See **Activity 5, "Analyze What Goes Down the Drain."**)

In groups they can:

- Monitor water quality as part of a class, school, regional, or international activity. (See **Activity 6, "Join a Monitoring Network."**)
- Clean up a stream or river, pond or lake, beach, etc. One source of information and assistance for starting a water quality monitoring and protection program is River Watch Network—a corps of over

6,000 volunteers working to restore and protect U.S. and Canadian rivers. Teachers, students, and citizens participating in River Watch programs are trained to conduct water quality tests. For more information, contact River Watch Network, 153 State Street, Montpelier, VT 05602. Phone (802)223-3840. (Also see information on GREEN in **Activity 6, "Join a Monitoring Network."**)

If you live near the coast, your students might like to participate in the annual beach cleanup program sponsored by the Center for Marine Conservation, 1725 De Sales St., N.W., Suite 500, Washington, D.C. 20036. (See **Activity 12, "Clean Up the Beach."**)

- Clean up litter along streets and highways so it does not wash into storm sewers and streams.
- Participate in and support community programs to collect household hazardous waste.
- Plant trees, shrubs, and grass to soak up nutrients before they flow into streams and rivers.
- Help educate your community about water pollution. For example, in Maryland, citizen volunteers are painting storm drains with the message, "Don't Dump, Chesapeake Bay Drainage," to remind people that what goes into a storm sewer ends up in the bay.

Suggestions for Further Reading

- Alliance for the Chesapeake Bay, *The Bay Book* (CRIS, 1990). First copy free, additional copies $1.00. Available by calling 1-800-662-2747.
- Tom Horton and William M. Eichbaum, *Turning the Tide: Saving the Chesapeake Bay* (Island Press, Washington, D.C., 1991).
- Mark K. Mitchell and William B. Stapp, *Field Manual for Water Quality Monitoring: An Environmental Education Program*. Order from William B. Stapp, 2050 Delaware, Ann Arbor, MI 48103 ($9.95).

1 Study a Body of Water

Choose a large body of water—a bay or lake that is important in your region. Determine the importance of this body of water by finding answers to the following questions: What is the geography/geology of the body of water? What flora and fauna are characteristic of it? How many people make a living from this body of water? What are their occupations? What events are important in the history of this body of water? Have any archaeological sites been excavated there? What is the condition of the water—is it improving or deteriorating? What is being done to plan for the use of this body of water? What laws have been passed or are being discussed to regulate the water and surrounding area? To obtain this information, contact appropriate state or provincial agencies, such as the Department of Natural Resources, local historical societies, and foundations or private groups concerned with preserving that body of water (such as the Chesapeake Bay Foundation, Annapolis, MD).

Skills Emphasis:* *Geo I 1, I 3, II 4, III 7–8, IV 9, IV 11–12, V 14–16; Hist I 1, I 8, IV 4; Science III 4, VII 2–5*

Suggested for Use in: *Geography, History, Earth Science, Biology, Environmental Issues.*

2 Follow a River

To help illustrate the fact that human activities far inland can cause marine pollution, have students, either individually or in small groups, trace the path of a local river to the ocean—for example, the Huron River to Lake Erie, over Niagara Falls to Lake Ontario, and out the St. Lawrence River to the Atlantic Ocean, the McKenzie River to the Arctic Ocean. Begin with the local watershed, with streams that are closest to your school. On a map, show major point and nonpoint sources of water pollution. Add on additional watersheds, showing major pollutants that may be added as the river moves toward the ocean. Where are pollutants that enter the water in your community likely to end up?

Skills emphasis: *Geo I 1, I 3, IV 9, IV 12, V 14–16; Science III 4, VII 2–5*

Suggested for use in: *Geography, Earth Science, Social Studies, Regional Studies.*

**See chart of Draft National Performance Standards at beginning of this unit.*

3 Study Your Water Supply

Where does your community's drinking water come from? Where are the reservoirs? Waste treatment plants? Are there any protected watersheds? If your water is drawn from a river, how many other communities upstream draw their drinking water from this river? How many downstream? What changes are planned to meet future demands, such as building dams, reservoirs, aqueducts? Present answers to these questions on a regional map. If possible, go on a field trip to visit a water or sewage treatment plant.

Skills Emphasis: *Geo I 1, IV 12; Science III 4, VII 2–5*

Suggested for Use in: *Earth Science, Biology, Social Studies, Environmental Issues.*

4 Estimate Water Usage

Two thirds of the people in the world use less than 13 gallons of water per day. To illustrate this, fill 13 one-gallon (48 liters) jugs with water and display them. Then ask students how many one-gallon jugs each student would have to fill to supply his or her needs for a day. Record each student's guess. Then have students make a more accurate estimate by doing research. One way to do this is by examining the family's monthly water bill. Another way is by figuring out how much water is used for various daily activities: taking a bath or shower, flushing the toilet, brushing teeth, washing hands, etc. According to the U.S. Environmental Protection Agency, a U.S. family of four uses about 243 gallons (920 liters) per day as follows: toilet flushing, 100 gallons (379 liters); shower and bathing, 80 gals. (303 liters); laundry, 35 gals. (132 liters); dishwashing, 15 gals. (57 liters); bathroom sink, 8 gals. (30 liters); utility sink, 5 gals. (19 liters). As a followup to this activity, have students investigate and publicize ways they and their families could save water. How much could they save by altering their habits (taking shorter showers, for example)? How much could they save by installing water-saving devices such as efficient shower heads? For each way to cut down on water usage, students should determine both the cost (for example, the price of a water-saving shower head or toilet) as well as the potential savings of money and water.

Skills emphasis: *Math X 1; Science III 4, VII 2–4*

Suggested for use in: *Social Studies, Environmental Issues.*

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5 Analyze What Goes Down the Drain

Have students do some detective work to determine substances they add to the water. First, give them five minutes to list everything they can think of that is poured down the drain in their household. Then, for homework, have them look around the house and list all the products that are regularly and occasionally put down the drain. Suggest they concentrate on the kitchen, closets or shelves where cleaning products are stored, bathroom cabinets, workroom or garage. Types of products include shampoos and other hair products, soaps, detergents, bleach, specialized cleaners (glass, toilet bowl, drain cleaners), ammonia, etc. What types of chemicals do these products contain (read the labels)? Compare the lists, based on research, with the preliminary lists. Are students surprised to discover the variety of substances their household adds to the water? Discuss the potential health and ecological effects of improper disposal of these substances. Discuss safe disposal methods for household products that should NOT be poured down a drain or sewer, such as motor oil, pesticides, paint, and turpentine. Have students suggest alternatives to common household chemicals. (See **Activity 11**, below.) As an alternate or complementary activity, have students study the school building to determine what goes down the drain in the kitchen, science labs, art studios, home economics rooms, and other classroom areas where chemicals, paints, and cleaners are used. What kinds of cleaning agents are used by the maintenance staff? Should any of these substances not be disposed of in the sewage system? A good source of information is the pamphlet, "Household Hazardous Waste: What You Should & Shouldn't Do." A copy is available free from the Water Pollution Control Federation, 601 Wythe Street, Alexandria, VA 22314. Send a self-addressed stamped envelope.

Skills Emphasis: *Science II 2, III 4, VII 2–5*

Suggested for use in: *Biology, Chemistry, Home Economics, Earth Science.*

6 Join a Monitoring Network

Thousands of students around the world are involved in water quality monitoring projects such as the Global Rivers Environmental Education Network (GREEN) or Watershed Worlds (Thames Science Center, New London, Connecticut). GREEN links schools in the United States, Canada, Asia, Africa, Latin America, and Europe through newsletters, computer conferencing, workshops, and other forums. Students are able to discuss their own water monitoring projects with students and teachers in other areas of the world. For information, contact GREEN, 721 East Huron Street, Ann Arbor, MI 48104. Phone: (313) 761-8142; Fax: (313) 761-4951. Watershed Worlds, Thames Science Center, 77 Long Wharf, Newport, RI 02846. Phone (401) 849-6966.

Skills emphasis: *Geo I 1, IV 4, IV 12, V 14–16; Science II 2, III 4, VII 2–5*

Suggested for use in: *Biology, Ecology, Environmental Issues, Earth Science, Geography, Social Studies.*

7 Create a Public Service Advertisement

Cool, clean water. Everybody loves it, but in some places it is becoming a rarity. Have students create antipollution advertising selling the value of clean water. An ad might focus on persuading people to do something that benefits water. Or, an ad might try to persuade people to avoid doing something that pollutes water. This activity is a good opportunity for students to use artistic or musical talents or display a sense of humor. Encourage individuals or groups to produce ads in a variety of forms: a taped commercial for radio, a videotaped commercial for public-access cable television, a poster, a combination of text and pictures for a magazine or newspaper ad. Perhaps your school newspaper would print some of the ads or some could be delivered over the school's public address system. Others might be displayed on bulletin boards.

Skills Emphasis: *Science III 4, VII 2–5*

Suggested for use in: *Social Studies, Art, Environmental Issues.*

8 Research the Clean Water Act

Have students investigate the United States Clean Water Act or your provincial Water Quality Statute: how the act came into being, what negotiations and/or lobbying may have been involved, how rigorously it is enforced today. Similar state or local legislation could also be researched. Students may want to find out how well their own local government complies with national and state laws. What action has the local government taken? What sorts of support or penalties have regulatory agencies used to encourage compliance?

Skills emphasis: *Civics III 3–4, III 6; Science III 4, VII 2–5*

Suggested for use in: *Social Studies, Regional Studies, Environmental Issues.*

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9 Develop an In-Depth News Report

Have each student find one newspaper article describing an event that is related to water pollution. The exercise will be more fun if articles can be gathered from a variety of newspapers including those from another part of the country or another part of the world (a good opportunity for students who can read a language other than English). Have each student write a brief report providing a context for the event— analyzing the possible causes and results of this event and showing how it relates to the "big picture" of watershed pollution.

Skills emphasis: *Science III 4, VI 1, VII 2–5*

Suggested for use in: *Social Studies, Foreign Language, Environmental Issues.*

10 Publicize Plastic Pollution

Items made of nonbiodegradable plastic are an important source of marine pollution. Using plastic six-pack holders, fishing line, containers, and other items, students could create a display that shows how these items get into the oceans and how they damage wildlife and degrade beaches. The display might also include information about recycling plastic items and ways to cut down on the use of plastic, such as using recyclable or reusable glass containers. (A helpful resource for this activity is the following article: Michael Weisskopf, "Plastic Reaps a Grim Harvest in the Oceans of the World," *Smithsonian* (March 1988), pp. 58–66. Also see *Citizen's Guide to Plastics in the Ocean*, Center for Marine Conservation, Washington, D.C.

Skills emphasis: *Science III 4, VII 2–4*

Suggested for use in: *Biology, Ecology, Regional Studies, Environmental Issues, Art, Earth Science.*

11 Try Out Alternative Cleaning Products

Because many commonly used cleaning products can be harmful to the environment, many people are turning to alternatives. Some are old-fashioned, natural products such as vinegar, baking soda, washing soda, table salt, lemon juice, and borax. For example, an all-purpose cleaner can be made by adding ¼ cup sudsy ammonia, ¼ cup vinegar, and 1 tablespoon baking soda to 1 gallon of hot water. Have students research and try out these alternative cleaners. Some information is available in advertisements and on packages (for example, the 20 Mule Team Borax ® package). Many "recipes" for cleaning substances are given in Debra Lynn Dadd's book, *Nontoxic, Natural, & Earthwise* (Jeremy P. Tarcher, Inc., Los Angeles, California, 1990). How much do these cleaners cost compared with the cleaning products their families usually use? How effective are the alternative cleaning products?

Skills Emphasis: *Science II 2, III 4, VII 2–4*

Suggested for Use in: *Earth Science, Biology, Chemistry, Home Economics.*

12 Clean Up the Beach

An annual beach cleanup is held each fall, coordinated by the Center for Marine Conservation. Complete instructions for participating are available by writing to the Center at 1725 DeSales Street, N.W., Suite 500, Washington, D.C. 20036. *All About Beach Cleanups* includes instructions for enlisting volunteers, finding funding, doing publicity, and counting and disposing of litter. If you're not near the coast, clean up a local stream, pond, or lake.

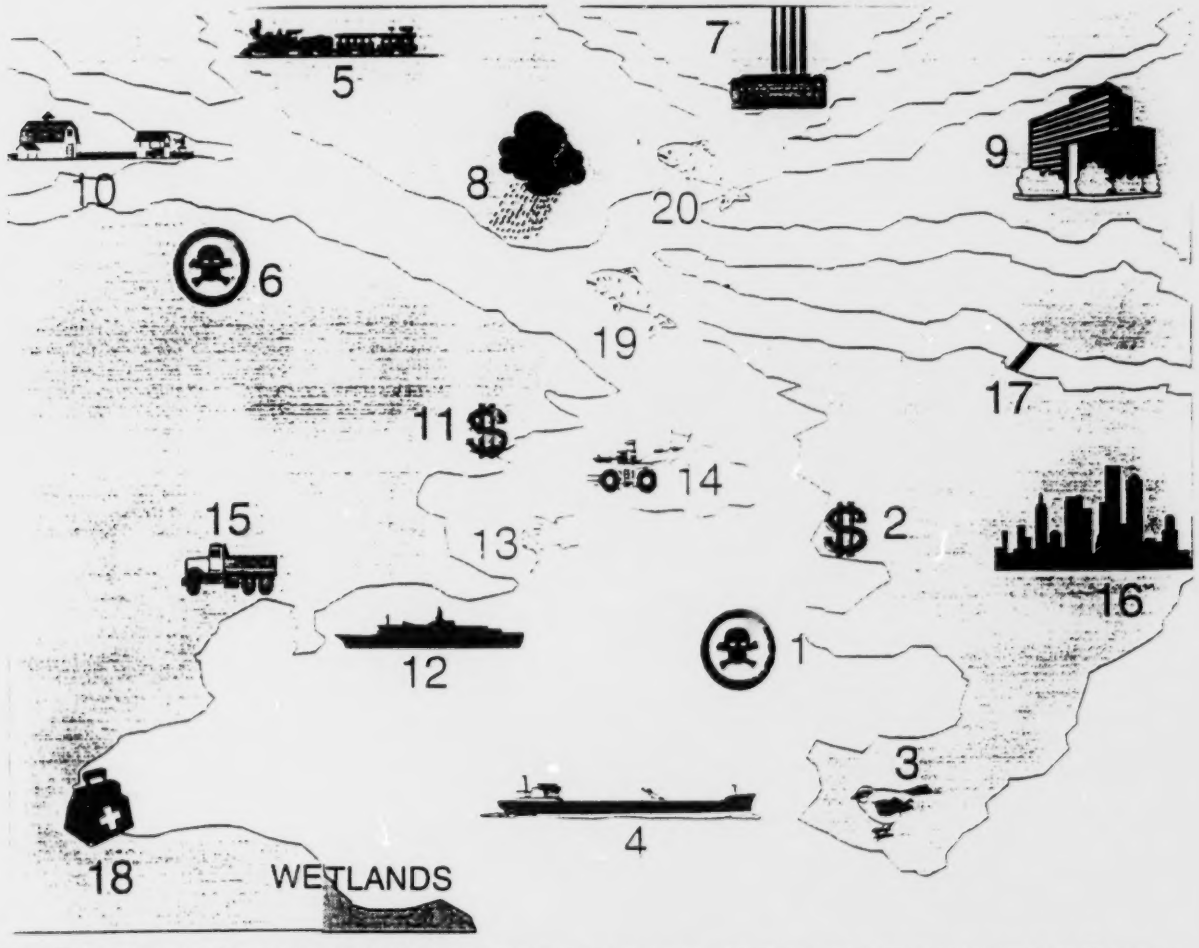
Skills Emphasis: *Science III 4, VI 3, VII 2–4*

Suggested for Use in: *Earth Science, Environmental Issues, Social Studies.*

Audiovisual Resources

- *Into Deep Water*, Turning the Tide Series, VHS, 26 min. *Why clean drinking water is becoming scarce.*
- *Eastern Exposure*, VHS, 48 min. available from WUSA-Eastern Exposure, 4100 Wisconsin Ave., NW, Washington, D.C., 20016. (202) 895-5805. *This film explores the Chesapeake Bay watershed.*
- *Great Lakes, Fragile Seas*, National Geographic Society, VHS, 59 min. *Concerned groups attempt to repair past damage and confront new threats to North America's Great Lakes.*
- *Water*, 59 min., CLV video disc, plus introductory video to *Perspectives in Science*, 22 min. VHS, National Film Board of Canada, Bullfrog Films. *Part of an ongoing series of interactive CLV videodiscs.*
- *Without Borders* (1989), VHS, 120 min., TBS, Inc. *Fighting to save five of the world's greatest rivers.*

Watershed Map and Questions



Note: This is not a map of an actual watershed but represents an area where the events used in this exercise could take place. The events selected for this exercise have all actually occurred, but in various locations; not in a single area.

Questions about Watershed Map and Events

Part I. Answer these questions for each event.

1. What area of the watershed is likely to be affected by this event?
2. Is this event likely to improve or hurt water quality? Why?
3. Are the effects of this event likely to be short term? Long term? Both?

Record your answers on a separate piece of paper, using the following format:

Event No. Area Affected Effect on Water Quality

1. _____

Part II. Summary Questions

How many different kinds of pollution are entering the water?
How many different sources of pollution can you identify?
Which instances of water pollution are accidental?
Which events might have the most effect on the watershed?
How might upstream events affect downstream users?
Which upstream events affect downstream environments?
What must be done to protect water quality at the wetlands? At the swimming beach?

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Events in the Watershed

The list below tells what has happened in the watershed during a period of three months. To find where each event occurred, locate the corresponding number on the map. For example, number (1) on the map shows where deposits of toxic metals have been discovered.

1. Tests reveal deposits of toxic metals on the floor of the bay near a chemical plant closed 10 years ago.
2. City budget problems mean no new money for a plan to protect an upstream watershed.
3. Marshes are set aside as a wildlife sanctuary after environmental groups defeat plans for an industrial park.
4. A tanker hits another ship during a storm and spills thousands of gallons of crude oil.
5. A railroad tanker car derails on a bridge, spilling 20,000 gallons (75,700 liters) of poisonous pesticide into the river.
6. Toxic metals, buried in a landfill 20 years ago, have leaked and contaminated the groundwater. Tests show they have reached the river.
7. Increased fines for pollution, coupled with new technology, motivates a factory to cut down on chemicals in waste water added to the river. The plant manager is delighted to find that reducing pollutants actually saves the company money.
8. A heavy thunderstorm overloads storm sewers. The sewage treatment plant is overloaded, and raw sewage is discharged into the river.
9. The forest is cleared to make way for a new planned community of industrial, commercial, and residential buildings.
10. Farmers begin using new techniques to cut down on fertilizer and pesticide use and reduce soil erosion.
11. The town budget squeeze means no money to pay for maintaining equipment at the sewage treatment plant.
12. A barge hits a stone jetty and spills thousands of gallons of kerosene.
13. A study of the local coastline reveals many pipes draining raw sewage into the river.
14. Now that this island has its first water treatment plant, six new subdivisions are under construction.
15. The owner of a small factory is found guilty of illegally dumping nitric acid into sewers.
16. The city modernizes its sewage treatment plant upgrading the degree of treatment from primary to secondary. Primary sewage treatment uses screens and settling tanks to remove solids. Secondary treatment uses bacteria to remove 90 percent of the oxygen-demanding wastes.
17. A new dam built for flood control is reducing seasonal flows of freshwater and nutrients to the bay.
18. A bathing beach is closed after medical waste is found washed up on shore.
19. The sale of shellfish is restricted after tests reveal unsafe levels of a toxic industrial chemical.
20. The average catch of fish drops drastically after sediments from upstream logging and erosion cloud river waters.

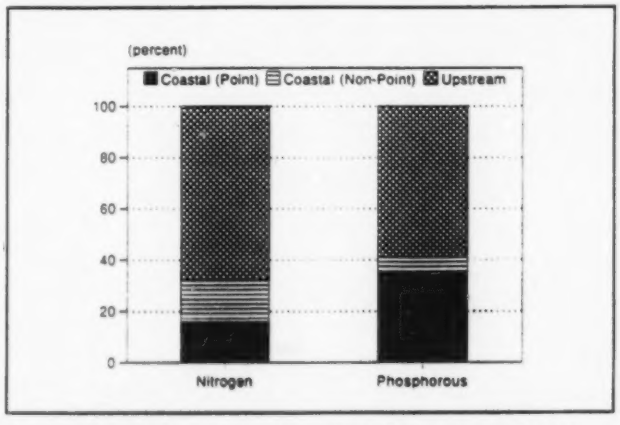
Facts about Watershed Pollution

Watersheds or river basins are dominant features of the Earth's surface. In many countries, pollution of watersheds is a severe problem. Pollution can make the water supply unfit for people to use for drinking and bathing and for growing and preparing food. Water pollution can also affect natural biological systems, causing unsafe levels of organic residues and metals to build up in fish and other marine life. Pollution can lead to the overfertilization of waters and loss of oxygen needed by marine life.

Both groundwater and surface water can carry pollutants great distances. Watershed pollution has many different sources: agriculture, industry, logging, mining, cities and towns, drilling, and transportation. Large watersheds often generate large river flows with the potential for transporting great amounts of sediment, toxins, and nutrients into coastal waters.

Most of the world's coastal areas are polluted. Recent studies have shown that a large proportion of coastal pollution comes from the watershed. For example, a 1991 study of 85 coastal watersheds in the United States found that upstream sources accounted for about 70 percent of the nitrogen and 60 percent of the phosphorus entering coastal estuaries. (See Figure 1.) Enclosed waters with low inflow and outflow, such as the Chesapeake Bay and the Mediterranean Sea, are highly vulnerable to pollution. Coastal areas with high rates of water turnover are less likely to become heavily polluted because they are flushed out more quickly.

Figure 1 Sources of Nitrogen and Phosphorus in U.S. Coastal Waters, 1990



Source: National Oceanic and Atmospheric Administration (NOAA) and U.S. Environmental Protection Agency Team on Near Coastal Waters, *Strategic Assessment of Near Coastal Waters*, 4 vols. (NOAA, Washington, D.C., 1989–91).

Sources and Types of Pollution

- *Domestic waste water.* Sewage contains disease-causing bacteria and viruses. Waste water usually contains high levels of nitrogen and phosphorous compounds that lead to overfertilization of water.
- *Industrial wastes.* Heavy metals and synthetic organic compounds are produced by the pulp and paper, chemical, petrochemical and refining, metalworking, food processing, and textile industries. Heavy metals such as zinc, lead, cadmium, chromium, mercury, and copper can cause serious health problems. Sometimes metals and other wastes leach out from dumps and enter groundwater. Besides being discharged into water, industrial wastes are also released into the air. Rain and snow pick up airborne pollutants and deposit them on both land and surface water. This is called *atmospheric deposition.*
- *Land use runoff.* Rain washes sediment, fertilizers, and pesticides into rivers. This is a *nonpoint* source of pollution in contrast to a *point* source of pollution, which comes from a specific source such as a drainage pipe. In the United States and Canada, agriculture has become one of the largest nonpoint source of water pollution.
- *Litter.* Litter, especially plastic items such as six-pack container rings, is a serious form of marine pollution. Because it floats, plastic travels long distances, degrades beaches, and can entangle or kill birds, seals, turtles, and other marine life.
- *Petroleum.* Most oil spills occur in coastal waters where oil is being drilled or transported. Usually, oil spills are accidental, as in the case of the *Exxon Valdez* spill in Alaska in 1989. However, in

Facts about Watershed Pollution *(continued)*

1991, Iraqi soldiers deliberately released oil into the Persian Gulf. Oil fouls beaches, kills birds, fish, animals, and causes long-lasting problems for many levels of marine organisms.

Trends in Watershed Pollution

Documentation of high levels of pollution is becoming available for certain major watersheds, but no information has been collected for watershed pollution from a worldwide perspective. What is generally known, however, is that ever-increasing volumes of toxic and persistent substances are being discharged into air, surface waters, aquifers, and landfills. Urbanization is having the greatest indirect influence on water quantity and quality, according to the Preparatory Committee for the United Nations Conference on Environment and Development (UNCED). If the causes of pollution and waste are not dealt with, pollution will worsen as economies expand.

Typically, governments have focused on obvious sources of coastal pollution—such as discharges of sewage—and have paid little attention to upstream sources of coastal pollution. In the 1980s, billions of dollars were spent to reduce the flow of sewage and industrial wastes into coastal waters, resulting in cleaner water in some areas. In Europe, 72 percent of the sewage is treated. However, in most developing countries, only a small fraction of the sewage is treated.

Most of the world's countries lack effective, integrated programs to protect water quality. Agencies responsible for providing clean water generally have no control over many activities that affect water quality, such as the location of hazardous waste dumps and agricultural practices.

The potential for local, national, and international conflicts over water quality is real, but few international treaties have been signed to control land-based sources of pollution. Only five regions in the world are covered by international agreements aimed at reducing land-based pollution: the North Atlantic, the Baltic, the Mediterranean, the Persian Gulf, and the Southeast Pacific.

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Comparing Water Use and Pollution in Industrialized and Developing Countries

Characteristic	Industrialized Countries	Developing Countries
	Water Use	
Water Use Per Capita	Heavy per capita usage. Highest usage per capita is in U.S., Canada, Switzerland. Usage is stabilizing.	Small per capita use. Water usage increases as living standards go.
Where is Water Used	Mostly for industry and agriculture, followed by domestic use.	Mostly for irrigated agriculture, especially in Asia, followed by industry, then domestic use.
Access to Water and Sanitation	Water and sanitation generally available. Only small population increases are expected.	Large segments of the population do not have safe drinking water and sanitation services. A rapidly growing urban population will create an increasing demand for water and for sanitation.
	Pollution Control	
Domestic Waste Water	Most countries treat domestic wastes. In Central European countries, lack of sewage treatment systems is a serious problem.	Almost all urban sewage is discharged without treatment.
Industrial Wastes	Strictly regulated in most industrialized countries, but pollution exists from discharges made up to 100 years ago. Some accidental spills. In Central Europe, industrial wastes laced with heavy metals and toxic chemicals have caused river quality to deteriorate dramatically and the Black and Baltic Seas to become heavily polluted. Acid lakes and rivers are a problem in North America and Europe.	Largely untreated. A significant and growing problem. Problems with acidification developing in Southern China and tropical Africa.
Land Use Runoff	Fertilizers and pesticides are a continuing problem. Soil washed from agricultural and urban areas and oil from city streets pollute rivers.	Uncontrolled use of fertilizers and pesticides is creating a growing health problem. In areas of heavy deforestation, soil erosion leads to sediment-clogged rivers.

Major River Basins of the World

Source: World Resources Institute in collaboration with the United Nations Environment Programme and the United Nations Development Programme, *World Resources 1992-93* (Oxford University Press, New York, 1992), p. 165.

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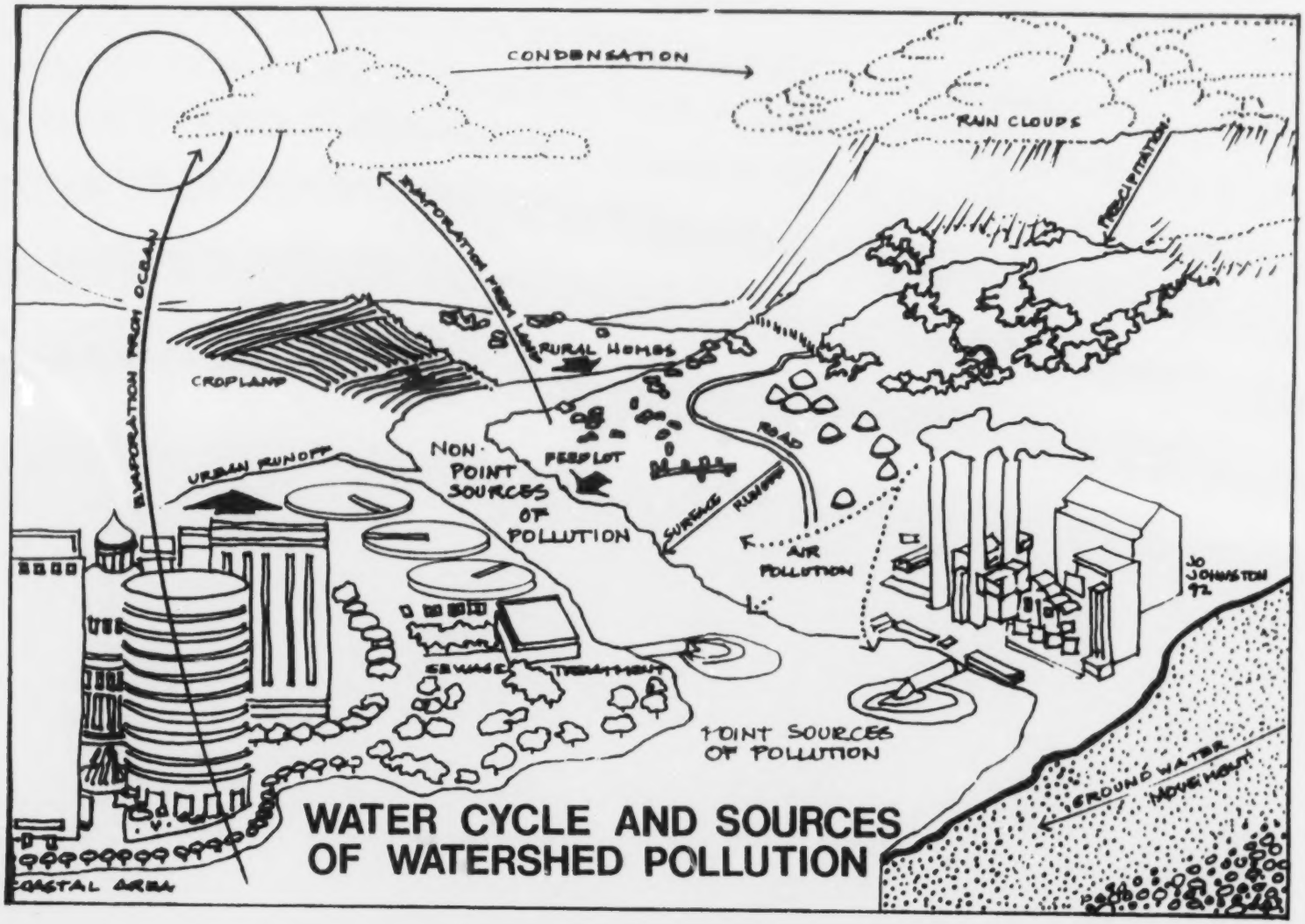
How Water Becomes Polluted



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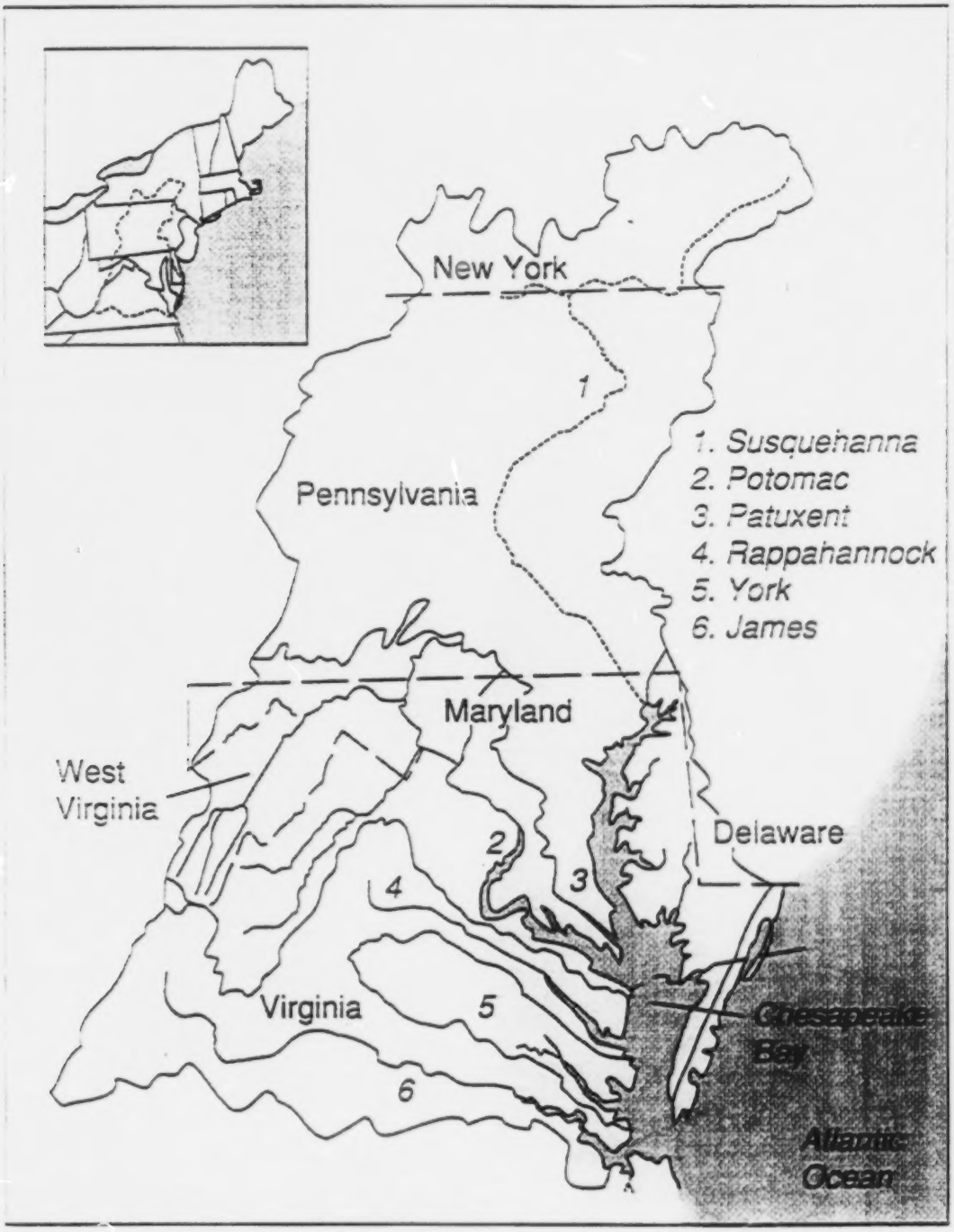
Source: Adapted from G. Tyler Miller, Jr., *Living in the Environment: An Introduction to Environmental Science*, 7th ed. (Wadsworth

Watershed of the Chesapeake Bay



Source: U.S. Environmental Protection Agency (EPA), *Chesapeake Bay Program: Findings and Recommendations* (EPA, Philadelphia, 1983), p. 6.

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Sources of Teaching Materials

Audubon Population Program
801 Pennsylvania Ave., SE.
Suite 301
Washington, DC 20003 USA
Phone: 202/547-9009

Bullfrog Films
Oley, PA 19547 USA
Phone: 1-800/543-FROG

Center for Marine Conservation
1725 DeSales St., NW.
Suite 500
Washington, DC 20036 USA
Phone: 202/429-5609

Educational Images Ltd.
P.O. Box 3456
Westside Station
Elmira, NY 14905 USA
Phone: 1-800/527-4264

Films for the Humanities and Sciences
P.O. Box 2053
Princeton, NJ 08543-2053 USA
Phone: 1-800/257-5126 or 609/452-1128
Fax: 609/452-1602

Friends of the United Nations Environment Programme (FUNEP)
2013 Q Street, NW
Washington, DC 20009 USA
Phone: 202/234-3600

Griesinger Films
7300 Old Mill Road
Gates Mills, OH 44044 USA
Phone: 216/423-1601

Information Services
Fisheries and Oceans Canada
Head Office—Centennial Towers
200 Kent Street
Ottawa, Ontario
K1A O16 CANADA
Phone: 613/993-0600

Minister of Environment
Jean J. Sharest
Environment Canada
Les Terrases De La Chaudiere
10 Wellington St.
Hull, Quebec
K1A OH3 CANADA
Phone: 819/997-2800

The American Forum for Global Education's National Clearinghouse for Development Education
45 John Street, Suite 908
New York, NY 10038 USA
Phone: 212/732-8606

National Consortium for Environmental Education and Training
School of Natural Resources and Environment
University of Michigan
Ann Arbor, MI 48109-1115 USA
Phone: 313/763-1312

National Film Board of Canada
P.O. Box 6100, Station A
Montreal, Quebec
H3C 3H5 CANADA
Phone: 514/283-9000

National Geographic Society Educational Services
Department 90
Washington, DC 20006 USA
Phone: 1-800/368-2728
(Maryland: 301/921-1330)

Population Reference Bureau, Inc.
777 14th Street, NW
Washington, DC 20005 USA
Phone: 202/639-8040

Sunburst/WINGS for Learning
101 Castleton Street
P.O. Box 100
Pleasantville, NY 10570-0100 USA
Phone: 914/747-3310

Turner Broadcasting System Library
Tape Sales
One CNN Center
Atlanta, GA 30348 USA
Phone: 404/827-1335

UNESCO–UNEP International Environmental Program (IEEP)
7, place de Fontenoy,
75700 Paris, FRANCE
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Teacher's Survey
Teacher's Guide Units

(Please use additional paper if necessary)

1. Which *World Resources Teacher's Guide* unit did you use?

____1. Biodiversity
____2. Car Trouble
____3. Citizen Action
____4. Energy, Atmosphere, and Climate
____5. Natural Resource Economics
____6. Oceans and Coasts
____7. Population, Poverty, and Land Degradation
____8. Sustainable Development
____9. Two Giants: China and India
____10. Watershed Pollution
____11. Women, Equity, and Sustainable Development

2. Course(s) in which you used *World Resources Teacher's Guide* units?

____History ____Geography ____Science
____Ecology ____Biology ____Chemistry
____Environmental Studies ____Environmental Science ____Other

3. Which sections of the unit did you find most useful?

____Teaching Strategies
____Student Enrichment Activities
____Student Handouts
____Overhead Transparency Masters
____Reading and AV Lists

4. How much do you think you will use the *World Resources Teacher's Guide* units in the future?

____Often ____Occasionally ____Rarely

5. Did you use the Goals 2000 draft national performance standards to select material from the units?

____Yes ____No

6. If yes to the above question, which performance standards did you teach?_____

_____

7. Were the recommended activities in the unit useful in teaching those standards?

____Yes ____No

8. What features could be added to the *Teacher's Guide* to make it more useful to you?

_____

_____

_____

9. In what setting did you use the *Teacher's Guide* units?

____Middle school ____12th grade ____Nature center
____High School ____Community college ____Zoo
____10th grade ____College or university ____Museum
____11th grade ____Adult education ____Other

10. Was the material appropriate for your audience?

___Yes No, because_____

11. If you used the unit in a school, how much class time did you and your students spend on it?

___Less than 1 class ___2–3 classes ___1–2 weeks

___1 class ___4–5 classes ___More than 2 weeks

12. Do you regularly teach about global environmental issues?

___Yes ___No

13. If you don't regularly teach global environmental issues, did you find this unit offered enough information and materials to construct your lesson?

___Yes No, I also needed_____

14. Did you use other WRI materials with this unit?

___Yes ___No

If yes, which ones_____

15. Because new units of the *Teacher's Guide* are being developed, it is helpful for us to learn how the materials work. Did they engage your students? Prompt lively discussion? Help make what seemed abstract issues vivid? Please be specific with negative *or* positive comments.

_____

_____

_____

_____

Name_____

School or Organization_____

Address_____

_____

May we call you to discuss your suggestions?

___No Yes, I can be reached at_____

Please return to:

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ATTN: Mary Paden, Teacher's Guide
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